Infrared

The term "infrared" refers to a broad range of frequencies, beginning at the top end of those frequencies used for communication and extending up the the low frequency (red) end of the visible spectrum. The wavelength range is from about 1 millimeter down to 750 nm. The range adjacent to the visible spectrum is called the "near infrared" and the longer wavelength part is called "far infrared".

In interactions with matter, infrared primarily acts to set molecules into vibration.

Frequencies: .003 - 4 x 10^{14} Hz
Wavelengths: 1 mm - 750 nm
Quantum energies: 0.0012 - 1.65 eV

Electromagnetic spectrum

Greenhouse effect	Radiation from hot objects	Red hot object	
	Infrared ear thermometers		

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Visible Light

The narrow visible part of the electromagnetic spectrum corresponds to the wavelengths near the maximum of the Sun's radiation curve. In interactions with matter, visible light primarily acts to set elevate electrons to higher energy levels.

White light may be separated into its spectral colors by dispersion in a prism.

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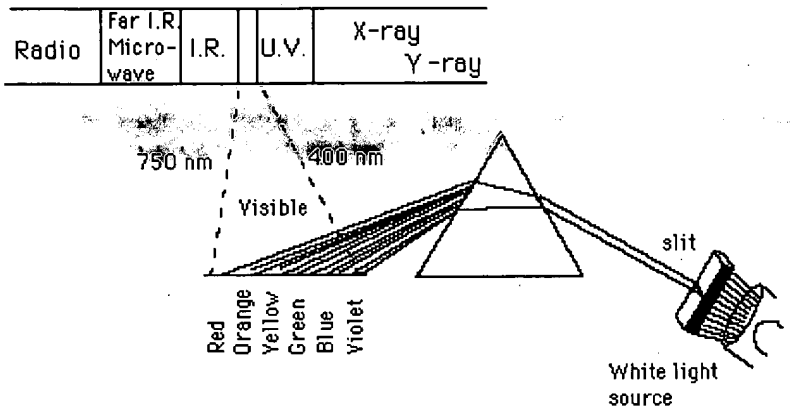

Frequencies: 4 - 7.5 x 10^{14} Hz
Wavelengths: 750 - 400 nm
Quantum energies: 1.65 - 3.1 eV

Electromagnetic spectrum

Spectral colors	Color vision	Characteristics of color

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Ultraviolet

The region just below the visible in wavelength is called the near ultraviolet. It is absorbed very strongly by most solid substances, and even absorbed appreciably by air. The shorter wavelengths reach the ionization energy for many molecules, so the far ultraviolet has some of the dangers attendent to other ionizing radiation. The tissue effects of ultraviolet include sunburn, but can have some therapeutic effects as well. The sun is a strong source of ultraviolet radiation, but atmospheric absorption eliminates most of the shorter wavelengths. The eyes are quite susceptible to damage from ultraviolet radiation. Welders must wear protective eye shields because of the uv content of welding arcs can inflame the eyes. Snow-blindness is another example of uv inflamation; the snow reflects uv while most other substances absorb it strongly.

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Frequencies: 7.5 x 10^{14} - 3 x 10^{16} Hz
Wavelengths: 400 nm - 10 nm

Quantum energies: 3.1 - 124 eV

Electromagnetic spectrum

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X-Rays

X-ray was the name given to the highly penetrating rays which emanated when high energy electrons struck a metal target. Within a short time of their discovery, they were being used in medical facilities to image broken bones. We now know that they are high frequency electromagnetic rays which are produced when the electrons are suddenly decelerated - these rays are called bremsstrahlung radiation, or "braking radiation". X-rays are also produced when electrons make transitions between lower atomic energy levels in heavy elements. X-rays produced in this way have have definite energies just like other line spectra from atomic electrons. They are called characteristic x-rays since they have energies determined by the atomic energy levels.

In interactions with matter, x-rays are ionizing radiation and produce physiological effects which are not observed with any exposure of non-ionizing radiation, such as the risk of mutations or cancer in tissue.

X-rays are part of the

Electromagnetic spectrum

Frequencies: 3 x 10^{16} Hz upward
Wavelengths: 10 nm - > downward
Quantum energies: 124 eV -> upward

Compton scattering of x-rays	Moseley plot of x-rays
Bragg spectrometer	Bragg's law

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Gamma-Rays

The term gamma ray is used to denote electromagnetic radiation from the nucleus as a part of a radioactive process. The energy of nuclear radiation is extremely high because such radiation is born in the intense conflict between the nuclear strong force and the electromagnetic force, the two strongest basic forces. The gamma ray photon may in fact be identical to an x-ray, since both are electromagnetic rays; the terms x-ray and gamma rays are statements about origin rather than implying different kinds of radiation.

In interactions with matter, gamma rays are ionizing radiation and produce physiological effects which are not observed with any exposure of non-ionizing radiation, such as the risk of mutations or cancer in tissue.

Frequencies: typically $>10^{20}$ Hz
Wavelengths: typically $< 10^{-12}$ m
Quantum energies: typically >1 MeV

Electromagnetic spectrum

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